CASE STUDY ON THE APPLICATION OF UNFC TO ENERGY AND MINERAL RESOURCES IN TAJIKISTAN

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Dushanbe, 2019

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EXECUTIVE SUMMARY

Natural resources, including minerals, oil, natural gas, ore and non-metallic raw materials, and other similar non-renewable resources, are the basis of modern industrial production.

The cost of mineral resources of Tajikistan that is determined in a planned economy, however, does not meet the requirements of modern markets: the prices of raw materials fluctuate greatly, and the value of mineral reserves determined today will no longer be acceptable tomorrow. In addition, there are no unified agreed approaches to the economic assessment of mineral resources at the stage of preliminary selection of investment projects, and this is one of the problems of attracting strategic investors to the mining industry.

Since currently the economic assessment of mineral resources is carried out separately (geologists determine the volume of mineral reserves (often approximate), and economists determine the value of these reserves for decades (only at existing rates, tax base, etc.), then as a result, an insufficient economic valuation of mineral reserves – the expected value of the net present value that can be obtained as a result of the development of deposits of estimated mineral resources – is carried out.

Field missions to the deposits located in the former republics of the USSR prove the positive fact that even in the current challenging economic conditions, the owners and operators of the deposits still carry out exploration work, investing significant amounts of money.

Yet typically, this process is led by "active managers" who do not have a geological education. Being subordinates, geologists conduct exploration according to their experience and the requirements of state bodies. Often geologists act within tight budget constraints, tacking between the requirements of owners and government agencies (although there are exceptions).

Owners need to get information on where the reserves are and put them on the balance sheet as quickly as possible in order to accelerate the start of field development. However, at a certain stage, when subsoil users want to get a loan or attract foreign investment, a problem arises that the conducted geological exploration works do not meet the requirements of international reporting systems (for example, Australian-Asian JORC-2012 or Canadian NI43- 101 [1, 2]). The consequence of that is that the available materials have almost no value to attract funding. To overcome this challenge, it might be recommended to observe the requirements of international codes for exploration (which require a minimum increase in costs), which allow obtaining a high-quality document, acceptable by all parties for consideration.

But most importantly, it is advisable to invite a specialist from an independent audit company both at the stages of exploration and when assessing resources / reserves, to ultimately develop a report on the quality of exploration work (QA / QC) in the summer when exploration is in progress, which will objectively reflect and indicate possible errors that are not too late to fix. As this is not requested by the state bodies, the latter accept what is written in the exploration reports, without questioning any data.

The main requirement for evaluating mineral resources, when assessing them according to international standards, is the quality of geological exploration and analytics. Of course, large mining companies have entire departments, dozens of experienced specialists in the field of block modeling work, who are constantly developing and improving their skills. Yet currently, the "Quality Assurance Quality Control of assay data" - "Quality Assurance and Quality Control of Analytical Research" are particularly poorly set up in small and medium-sized companies. The history allows to recall the case of Busang deposit in Indonesia, where omissions in analytics escalated into ‘Twentieth Century Scam’, after which the Western codes of exploration appeared, when the losses of investors amounted more than 100 million US dollars, and confidence in the Toronto Stock Exchange itself was undermined. Nowadays, it has very detailed requirements set out in the current NI43-101 Code.

The problems of classification of reserves and standardization of their various types have always been very relevant. After all, the “correct”, i.e. the classification that is most understandable to the investor allows companies to attract funds at more favourable conditions, which therefore reduces the cost of production and allows to increase profitability.

In Tajikistan, the system of classification and inventory accounting developed in the USSR is used. This system is now official, and it is it that is used by the State Commission for Reserves. At the same time, the approval of own reserves according to international standards is becoming more widespread. Given that in the modern world the number of many resource companies operating in different countries is growing, the need for a unified classification system is obvious. In view of this, this is a compelling reason for the country to assess applicability of UNFC to national energy and mineral resources.

For the purposes of this Case Study, two projects were selected (Fig.1):

1. Galenit polymetallic deposit
2. Naft oil deposit.

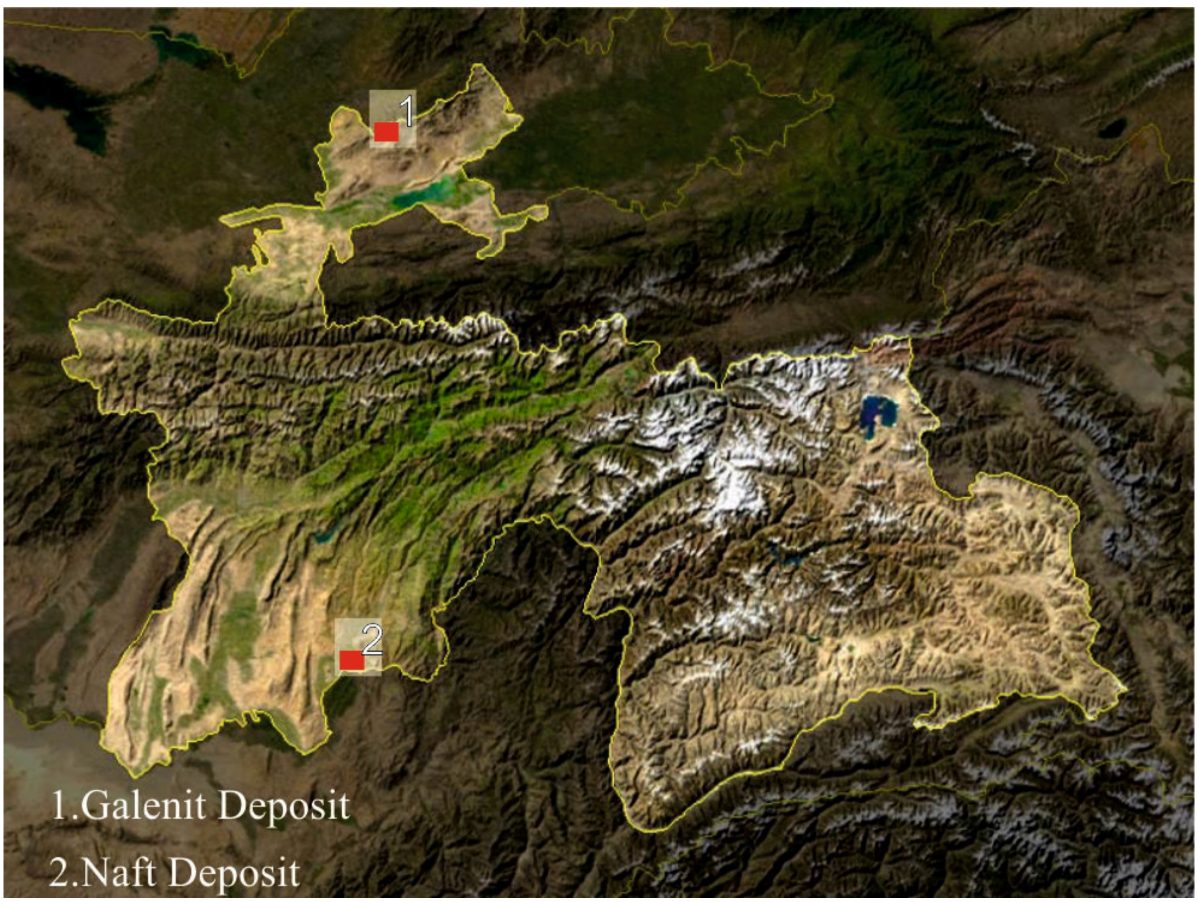

Fig.1 – Map of the territory of the Republic of Tajikistan, location of research objects

INTRODUCTION

The Republic of Tajikistan has abundant and available hydropower resources, which conditionate limited measures for large-scale development of of thermal energy sources, and relevant issues have not yet been resolved. While maintaining the priority for hydropower development, Tajikistan will have to make serious efforts to develop thermal energy as an important complement, as well as to eliminate the bottleneck in Tajikistan's energy sector, and support normal functioning economy of the country and ensure decent standard of living of its population.

Tajikistan has rich mineral resources. Over the years, about 600 deposits and more than 800 manifestations of 50 types of minerals have been discovered in the Republic.

The classification of reserves and predicted mineral resources is developed in accordance with Articles 5 of the Law of the Republic of Tajikistan "On Subsoil" and clause 8 of the Regulation on the State Commission of the Republic of Tajikistan on Mineral Reserves, approved by the Government of the Republic of Tajikistan. It establishes principles for classification of deposits, reserves and predicted (forecast) solid mineral resources that are common for the Republic of Tajikistan, yet it does not apply to underground water and oil and gas deposits.

The use of the latest methods and technologies for integrated geological exploration of the subsoil, as well as attracting capital of national and foreign investors on mutually beneficial conditions, will allow to achieve maximum results from the use of the country's natural resource endowment. In this regard, there is great interest in the application of the UNFC system in the mining and geological sector of the Republic.

Currently, proposals are being studied for revaluing reserves in accordance with the Australian Accounting Standards for Exploration Results, Mineral Resources and Ore Reserves (JORC) as well. Unlike the Soviet Union's one, this classification has an explicit division of each category of reserves and resources, based on economic and technical factors. In the Soviet system, it is not difficult to transfer some of the resources, e.g., of category P1 to reserves of category C2, part of reserves of category C2 to reserves of category C1, part of reserves of category C1 to reserves of category B, reserves of category B to reserves of category A.

When determining reserves in any system, common goals are understanding the situation regarding the possibility of industrial development of the field and making decisions on the appropriateness of development, determining the level of reliability of the assessment of its geological reserves. At the same time, the classifications use general principles for assessing deposits, which involve the collection and evaluation of geological data, determining the geometry of the ore body, calculating resources and reserves suitable for mining, while simultaneously checking the reliability of the obtained data.

NATIONAL CLASSIFICATION SYSTEM FOR MINERAL RESOURCES AND BRIDGING OR MAPPING TO UNFC

National classification system for mineral resources

National classification system for mineral resources covers the whole range of resources and reserves: from regional exploration planning to explored reserves with strictly defined boundaries at existing mines. The system is fully consistent with mining law and tax system. However, it is designed for leadership, management and planning, but not for market financing. Also, it provides for the use of manual rather than computerized methods of calculation.

Description and details of the national classification and management system

The national classification system for mineral resources distinguishes the following classes (unprofitable or less-profitable are classified as off-balance reserves.):

1. Forecast resources:
   - P3 – No accurate confirmed data;
   - P2 – According to geophysics / geochemistry / mapping;
   - P1 – According to limited data from drilling, ditch testing and exposure studies.
2. Reserves:
   - C2 – Systematic testing, additional research;
   - C1 – A denser network of testing, more detailed additional research;
   - B – A denser exploration network or partially explored ore reserves with strictly defined (rock) boundaries;
   - A – In-detail explored ore reserves with strictly defined boundaries. (A and B are usually only for detail studies areas within C1 category)

All reserves must be registered with the State Reserves Committee (GKZ RT) before obtaining a production permit. Industrial reserves are included in the State Balance. The current challenges with regard to classification system include the following:

- There are many different ideas about matching between the Soviet and international categories;
- A widespread misunderstanding of the State Reserves Control system and the difference between the classification systems;
- Resolution of these contradictions is too expensive: duplication of work with parallel calculation of resources / reserves according to GKZ RT and the international system;
- As a result, reserves estimate for the purposes of State Reserves Control and the international system often differ dramatically.

The State Reserves Control system divides 4 classes of geological complexity of solid minerals deposits (from the simplest “1” to the most complex “4”) to determine the required density of the exploration network. The specified complexity class also determines the levels of categories of resources and reserves that can be assigned and included in the reporting for this solid minerals object. The allocation of solid minerals resources is based on the level of geological exploration, and also includes off-balance reserves subject to the existence of reasonable prospects for their cost-effective production in the future.

Comparison of national classification system with UNFC and other international systems

The JORC classification easily matches categories A, B and C1. For these categories, all technical parameters have been established and economic calculations have been sufficiently made to begin development of deposits.

Reserves of category C2 in adjoining blocks can be used in the calculations as a potential for the growth of industrial reserves. In areas within which there is no object with reserves of categories A, B and C1, reserves of category C2 may correspond only to designated or even calculated resources. There is also such a category of reserves as “Off-balance”. Such reserves, even with a sufficiently high degree of knowledge, cannot be comparable with the designated and calculated resources, since their development is currently economically unprofitable (however, with big reservations, off-balance reserves can be included in the feasibility study for future mining).

Correspondence of GKZ RT (Soviet) and the JORC classification systems is presented in Tab.1. Comparison of the classification system of reserves and forecast resources of solid minerals of the Republic of Tajikistan with UNFC can be presented as in Tab.2. Table for definitions of categories and additional explanations and comparisons with the classification of mineral reserves operating in the Republic of Tajikistan is presented in Annex.

Tab. 1 – Correspondence of GKZ RT (Soviet) and the JORC classification systems

GKZ RT	JORC
Reserves A and B	Proved Reserves / Certain Resources
Reserves C1	Proved and Probable reserves / Designated Resources
Reserves C2	Probable reserves / Designated and Calculated Resources
Reserves P1	Calculated resources
Reserves P2	Forecast resources
Reserves P3	No equivalents

Tab.2 – Comparison of the classification of reserves and forecast resources of solid minerals of the Republic of Tajikistan with UNFC

<table>
<tr><th colspan="7">Classes defined by categories and sub-categories</th><th rowspan="3">GKZ RT reserves and forecast categories</th></tr>
<tr><th rowspan="11">Deposit</th><th colspan="2" rowspan="2">Class</th><th rowspan="2">Sub-class</th><th colspan="3">Categories</th></tr>
<tr><th>E</th><th>F</th><th>G</th></tr>
<tr><td rowspan="7">Known Deposit</td><td rowspan="3">Commercial Project</td><td>On production</td><td>1</td><td>1.1</td><td>1,2,3</td><td>A, B, C_1</td></tr>
<tr><td>Approved</td><td>1</td><td>1.2</td><td>1,2,3</td><td>B, C_1, C_2</td></tr>
<tr><td>AOR development</td><td>1</td><td>1.3</td><td>1,2,3</td><td>C_1, C_2</td></tr>
<tr><td rowspan="2">Potential commercial Project</td><td>Justified</td><td>2</td><td>2.1.</td><td>1,2,3</td><td>C_1, C_2</td></tr>
<tr><td>For development</td><td>2</td><td>2.2</td><td>1,2,3</td><td>C_1, C_2, P_1</td></tr>
<tr><td rowspan="2">Non-commercial Project</td><td>Pending exploration</td><td>3.2</td><td>2.3</td><td>1,2,3</td><td>C_2, P_1</td></tr>
<tr><td>Development not viable</td><td>3.3</td><td>2.3</td><td>1,2,3</td><td>P_1, P_2</td></tr>
<tr><td rowspan="2">Potential Deposit</td><td rowspan="2">Exploration Projects</td><td>[No sub-classes defined]</td><td>3.2</td><td>3</td><td>4</td><td>P_3</td></tr>
<tr><td>Additional quantities in place</td><td>3.3</td><td>4</td><td>4</td><td>P</td></tr>
</table>

CASE STUDY I: APPLICATION OF UNFC TO MINERAL DEPOSIT GALENIT

Background information on the project

The Galenit deposit, studied over 10 years (1950-1960), was explored in detail to a depth of 200 m. Its surface is mapped on a scale of 1:1000 on an instrumental basis of the same scale. The ore zone from the surface has been explored by ditches, pits and short adits. To the depth, the field was studied by 2 adit horizons and 2 horizons from the mine. Thus, by exploration work, Galenit field has been explored with enough detail both on the flanks and to the depth and is prepared for exploration.

Within the deposit, 4 main ore bodies and 11 small ore lenses with industrial ores and 11 ore bodies with off-balance ores were noted. For all ore bodies, reserves have been calculated. Total amount of reserves calculated for Galenit field and the surrounding area is presented in Tab.3.

Tab.3 – Reserves calculated for Galenit field

Category	Ore	Lead	Zinc	Copper	Bismuth	Cadmium	Silver
	thousand tons				tons		kg
$B+C_1$	7646,3	127,8	183,7	11,85	819,40	1925,2	134059,4
C_2	3707,8	42,3	103,8	2,79	254,71	523,1	78957,3
P_1	1529,4	26,0	40,0				
Galenit Deposit area:							
C_2	1764,7	30,0	46,0				
P_1	1764,7	30,0	46,0				

The ore bodies are confined to Tudaksai fault, made by a powerful quartz vein. Mineralization is localized along crushing zones mainly in quartz and, in a subordinate value, in hydrothermally altered rocks (mainly in granodiorites and felsites, developed both inside the vein and near the latter). Ore bodies have the form of steeply falling veins and lenses, complicated by blows and pinches. Their strike coincides with the general strike of the fault plane and is north-east 27-350 m. The fall of ore bodies prevails north-west and vertical, but there are cases of reverse fall (south-east) with angles of incidence in both cases from 60 to 900. The length of ore bodies ranges 30-1000 m or more with an average thickness of 1,35 to 8.5, and an average lead content of 1.2-2.27% and zinc 2.27-3.20%. The average ore grade in the deposit is as follows: 1.67% lead, 2.61% zinc, 0.17% copper, 0.01% cadmium, 0.03% bismuth, and 18.8 g/t silver.

The ore in the vast majority is sulfide, easily enriched by selective flotation. The contents of lead and zinc in the concentrates exceed 50%. The value of the concentrate increases due to extraction from lead concentrate – bismuth and silver, and from zinc – cadmium and copper.

The prospects of the ore field are not limited to these deposits, though. Revaluation of some deposits is possible; during exploitation of deposits, a discovery of blind ore bodies is also possible.

In total, 3.7 million rubles were spent on Galenit deposit during its operation. The costs of exploration directly amounted 3.2 million rubles. The total number of estimated reserves in conventional lead is 325.6 thousand tons. Hence, the cost of exploring 1 ton of conditional lead costs 9.83 rubles, and 1 ton of ore costs 0.44 US dollars. Thus, the cost of exploring 1 ton of conditional lead in Galenit deposit is significantly lower than in other explored deposits of Karamazar.

The work performed at the Galenit field is characterized by high efficiency and profitability. Detailed exploration of the field (ditches passed through 20-25 m from each other, cuts through 25-30 m, height between horizons – 50-100 m) allows developing the field without additional costs. Moreover, according to the relief conditions, difficult mining conditions, relatively low stripping ratio (3.8-4.3 m^3/t), the field can be profitably mined open pit to a depth of 160-185 m, with a profit of 7-8% (with planned profit 5%).

In total, during the exploration of the field, ditches were completed in the amount of 10,415.9 m^3, 23 pits were drilled with a total depth of 278.4 m, 12 short-length adits were drilled with a total depth of 375.3 m, 23 surface wells were drilled with a total meter of 5.99 thousand meters, and 19 underground wells with a total of 652.7 running meters, 7 major tunnels were drilled with workings from them, 394 core samples and 10233 furrow samples were taken. Large volumes of exploration work carried out at the field ensured a high degree of reserves reliability.

The reserves were calculated for the B+C1 category in the following amounts:

- lead – 17.8 thousand tons;
- zinc – 183.7 thousand tons;
- copper – 11.85 thousand tons;
- cadmium – 1925.2 tons;
- bismuth – 819,4 tons;
- silver – 134.1 tons.

Reserves of categories under GKZ – B, C1, C2, in accordance with UNFC – E1, F1.2, G1,2.

The Galenite field is currently not being developed, while it is prepared for industrial development. The recommended mining method is open mining.

Socio-economic and socio-environmental aspects of the selected project

Economic aspects

The study of Karamazar has a rich history, the beginning of which dates back to the Middle Ages. The Galenit field was discovered in 1950.

The indigenous population of the region is Tajiks and Uzbeks. They are engaged in horticulture and cattle breeding, less often in agriculture on irrigated and rainfed lands. The population density is quite low, and its distribution is determined by the presence of permanent surface watercourses. Settlements are usually located in the middle course of rivers. The transport and economic conditions of the region are favorable and contribute to the development of the mining industry.

In the immediate surroundings of the Galenit deposit are the fluorite deposit Naugarzan and the Angren coal deposit. In the western part of the district there are polymetallic deposits Konimansur, Karatashkutan, Zambarak, Taryekan and Chukurdzhilga.

Due to the fact that the Galenit deposit is remote from mining enterprises, it is proposed to construct an enrichment plant directly near the deposit on the basis of the Galenit and Zakhkhanasai ores. In the future, the local ore base will be expanded due to several nearby polymetallic deposits. All these deposits are separated from each other by no more than 3-18 km.

Galenit field is connected by unpaved roads with the neighboring deposits and the district center of Shaidan village located 40 km south-west. From the regional center – the city of Khujand, where there is a railway station – the field is 145 km away.

To provide water for the future mine, it is proposed to use underground waters of alluvial-proluvial deposits of the Gudas River Valley. The calculated amount of water not only fully provides, but also significantly exceeds, the maximum demand in water for industrial, technical and household-drinking purposes, based on the estimated need for water.

From local materials for construction, rubble stone-granodiorite and clay can be used. In the Shaydan region there are deposits of limestone, sandstone and others. There is no construction and fixing wood, as well as fuel, so their delivery is required.

The State network may be utilized to supply electric power for the future production.

Socio-environmental aspects

Development of ore deposits is a type of economic activity that affects almost all components of the environment. The result of this effect is the pollution of the atmosphere, groundwater and surface water, soil cover, water withdrawal from the underground hydrosphere, soil from the earth's surface and rocks from the bowels. Below is an overview of the ecological state of the environment in the area of activity of the future enterprise.

1. Atmospheric air. The main sources of air pollution are mining facilities and technological processes of the processing plant. At the mine, the sources of hazardous emissions are operational blasting operations. For dust suppression, all workings will be equipped with devices for hydro irrigation, as a result of which dust emissions will be insignificant. In places of possible dust emission (jaw crusher, cone crusher), home-made rectangular-type wet dust collection units with a size of 2.5x1.5x1 m are installed. The boundaries of the regulatory sanitary protection zones for the facilities of the enterprise are adopted according to the standard. Predicted impact on the atmosphere is assessed as acceptable.
2. Water supply. Groundwater is the source of technical water supply to the mine, concentration plant and auxiliary manufactory located at the industrial site. The hydrogeological conditions of the development of the deposit are generally favorable, due to the sharply dissected relief with a low erosion basis, as a result of which groundwater drains intensively and does not accumulate. Due to favorable hydrogeological conditions, monitoring of the environmental status of groundwater in the area of the enterprise is not provided. Environmental impact on water resources is assessed as permissible.
3. Soil and land resources. Technogenic impact on soils and land resources in the area of the plant’s activity takes place at the sites of waste accumulators. The main production waste of the enterprise is the sludge (tailings) of the ore dressing process and the host rock. A tailing dump and a dump of enclosing rocks are provided for their storage. Minimization of the negative impact of these wastes on the environment is ensured by environmental measures provided for by the construction and operation projects of the plant. To restore the disturbed lands after the end of the life of the mine and the processing plant, restoration of the disturbed lands is provided. The predicted impact on soils, taking into account the development of estimated reserves, is assessed as permissible.
4. Vegetation and wildlife. The flora and fauna of the area where production facilities are located are very poor, and there are no specially protected species of animals and plants. The activities of the enterprise in the development of proven reserves will not lead to a

change in the existing species composition of the plant and animal life of the region. Subject to environmental and production requirements, the impact on the flora and fauna is expected to be within acceptable limits.

5. Social environment. The operation of the mine and the processing complex in compliance with the necessary environmental measures will be of positive importance, thanks to the creation of additional jobs and the receipt of valuable mineral raw materials.

With the completion of field development, the initial state of all environmental components in the areas occupied by production facilities will gradually recover.

The results of the environmental impact assessment conclude that the ecosystem that has developed in the zone of influence of the enterprise during the period of its operation, is stable, and no additional negative impact is expected during further development of the lower horizons of the field. The environmental measures envisaged by the construction and operation projects of the plant's production facilities are effective, no additional measures are required.

In the future, special attention should be paid to conducting further environmental monitoring in the area, as an important component of environmental protection measures.

Field projects status and feasibility

Technological aspects of feasibility

The technological properties of the ores of Galenit deposit were established by examining 7 technological samples, of which 5 were taken from underground workings and represented by sulfide and mixed ores, and 2 samples were taken on the surface from ditches through ore bodies. All samples were taken throughout the entire exploration of the deposit and characterized the main types of ores depending on their chemical and mineral composition, texture, structure and physical properties, and varieties of the same type.

The aim of the research was a detailed test of the enrichment of each type of ore, the development of methods and concepts of concentration with the establishment of qualitative and quantitative indicators. Before the enrichment test, a detailed study of the material composition was carried out by spectral, chemical, and mineralogical analyzes.

All samples were taken using the furrow method at sampling intervals with the industrial content of the useful component. The initial size of the material is 50 mm. Sample preparation for technological testing consisted of crushing the sample material and reducing the weight of the sample. The weight reduction of the sample was carried out in accordance with the fineness of the material according to the formula (1):

$$Q = Kd^2$$

where: Q – weight of the sample (kg); d – diameter of the largest piece of material (mm); K – coefficient applicable to the field (0.2).

The material composition of the ore bodies is ore-bearing rocks – hydrothermally altered granodiorites, highly silicified, and quartz. The main ore minerals in the samples are galena, sphalerite, chalcopyrite and pyrite.

At the deposit, 3 technological differences (types) of ores were identified:

1. sulfide;
2. mixed semi-oxidized;

3. oxidized (based on their characteristics the technological tests were conducted).

Technological tests were carried out mainly by flotation methods and consisted in the development of a technological enrichment scheme and a reagent mode in order to obtain conditioned concentrates by affordable means.

The research results should be considered satisfactory and, based on these data, the ores of the deposit are well-enriched.

As a result of technological tests, a processing scheme was proposed, including ore grinding up to 79.4% class-0.074 mm, main lead flotation (4 min), 2 rough lead concentrate cleanings (4 min or 1.5 min), agitation of lead flotation tailings with lime and sulphate (4 min), basic zinc flotation (8 min), 2 purifications of rough zinc concentrate (4 min and 4 min).

Thus, macroscopically isolated types of ores were subjected to technological tests. A study of the material composition of the samples established a complete analogy of the host rocks, as well as vein and ore minerals. The character of interspersing sulfides and their intergrowth with waste rock and among themselves is also similar. For mixed and oxidized ores, significant ironiness was noted and the composition of ore minerals characteristic of oxidized ores. However, each sample separately has some individual features, which were reflected in the choice for each of them of the technological scheme and reagent mode. The ores of the Galenit deposit are fairly easily enriched by flotation.

The issue of the enrichment of sulfide, mixed, and oxidized ores has been positively resolved, although a high recovery of the latter to concentrate has not been achieved for oxidized ores due to the presence of non-floating forms of lead. It should be taken into consideration that when processing these ores, 2 fundamentally different technological schemes are possible:

1. Processing of sulfide ores.
2. Processing of oxidized ores.

Mixed ores can be processed according to the scheme developed for sulfide ores with a corresponding change in the reagent mode. In this case, the following enrichment indicators are possible:

1. For sulfide ores – lead concentrates with lead content of 58.68% when extracting 90.8%, and zinc concentrates with zinc content of 50.90-45.06% when extracting the latter into concentrate 88.92-93.30%.
2. For mixed ores – lead concentrates with lead content of 45-50% with recovery of 88-70.75%, and zinc concentrates with zinc content of 45.50-50-55% with extraction of 60.0-85%.
3. For oxidized ores – lead concentrates with lead content of 44.85-42.0% with recovery of 77.5-71.2%.

In addition, it must be noted that lead concentrates contain up to 632.5 g/t silver, which increases the cost of these.

Performed detailed exploration and results

When choosing the Galenit field exploration methodology, the following main factors were considered:

1. The average and small sizes of ore bodies along strike and dip, their discontinuity, variable thicknesses of 0.5-30 m, a steep drop of 60-900.
2. Uneven distribution of useful components.
3. The rocky relief of the deposit, the confinement of the ore bodies to the fault zone made by a quartz vein, the latter stands in the relief for 15-20 m, forming a series of ledges. The vein along its entire length is intersected by three large ravines.
4. The water cut of the field is insignificant, the influx of water into the mine workings does not exceed 15-20 m^3/hour.
5. The rocks composing the deposit and the ore body are unstable, highly fractured and fragmented.

Exploration of such deposits by one borehole cannot give positive results, so, according to the drilling data, it is impossible to contour ore bodies sufficiently, to obtain reliable content of useful components, the intersection of fragmented ore zone rocks negatively affects core output. Such ore bodies can be most fully characterized only with the help of mine workings, especially since the relief favors their laying. Given the above factors, the Galenit field was explored mainly by mine workings in combination with wells.

According to the industrial classification proposed by GKZ RT, deposits of a type such as Galenit belong to the second subgroup of group II. The density of the exploration network for ore bodies of the deposit, attributable to the second subgroup of group II, for categories C, should be 75x100 m; for category B – 30x60 m. The ore bodies at the Galenit deposit were prospected using the following procedure.

The surface of the field is mapped at a scale of 1:1000 on an instrumental basis of the same scale. Ore zones from the surface were explored by ditches, the latter passed across the strike through 20-30 m. Due to the good exposure of ore zones, pits were drilled, mainly for opening ore bodies under powerful Quaternary sediments in ravine. The distance between them was taken 40-80 m.

The terrain conditions favored the exploration of the field with adits with a system of drifts and dispersal. Based on this, the field was sequentially explored by adit workings at the horizons:

- 1 adit horizon (adit No. 4-6; marks are 1629 and 1624 m, respectively);
- 2 adit horizon (adit No. 7; with workings to the level of 1578 m).

On the north-eastern flank, due to a sharp increase in the relief, additional adits No. 3, 5 and 13 of their mark 1673, 1701 and 1702m, respectively, were completed, the last 2 were exclusively for exploration of ore body No. 5.

All these workings were passed along the strike of the ore zone, and to intersect the power of all ore bodies, cuts were made from the indicated workings through 25-30 m. Such a dense network of exploration workings was adopted at the first stage of exploration of the field (until 1954) and was approved by GKZ RT; it is due to the above factors adopted when choosing the methods of field exploration.

From the beginning of field exploration, its deep horizons were explored by core drilling wells. Wells were drilled along the profiles, but the distances between the profiles were not maintained and ranged from 100 to 200 m.

The vertical distance between the wells ranged from 50 to 100 m. Due to the sharp curvature of the wells, the latter cut the ore body, but at a given depth, so the vertical distance between the points of cutting the ore bodies by the wells was obtained from 10 to 40 m. Wells were drilled from the bottom of the openings to the complete intersection of the fault zone.

Surface mine workings were sketched at a scale of 1:100 in the picket magazine of a standard sample, while one wall and the bottom of the ditch were sketched. The wall of the ditch, which was better exposed, was sketched. The sampling location was tied to the beginning of the ditch. Underground mining was documented at a scale of 1:50. Separate details were sketched on a larger scale, sketched in a picket notebook. In the horizontal workings, both walls and the roof were documented, which were drawn in the form of a reamer, according to the requirement of the instruction.

Along the line of conjugation of the right wall and the sole, the development, as it were, is cut and rotated around the line of conjugation of the left wall with the sole until the sweep coincides with the drawing plane. Documentation of scatterings and drifts was always carried out from the surveying point located in the center of the mine from which they pass.

Boreholes were documented in drilling logs, which recorded the penetration of wells on individual runs, the diameter of the drilling, the geological column, the percentage of core ascents by elevations, the sampling intervals, the data of measurements of anti-aircraft and azimuthal curvatures, the description of the core by intervals and the sampling data. Kern was marked on separate dies.

All mine workings were tested using the furrow method; the sample size was taken equal to a width of 10 cm, a depth of 5 cm. The furrow length was usually taken equal to 1 m. In order to clarify the confinement of mineralization to certain types of rocks, sections of furrow samples were limited to the limits of one breed variety; the furrow length ranged from 0.5 to 1.5 m. Since there are no clear contours of ore bodies at the deposit, ore zones were tested over the entire thickness of quartz veins, hydrothermally altered mineralized and fragmented rocks. In addition, contouring samples were taken at two to three meters in seismic power. Samples were taken along the ditches along the bottom, while the bottom of the ditch was leveled and cleaned.

Underground mine workings, traversed across the strike of ore bodies, were tested along the wall, approximately 1 m from the bottom. At the same time, the wall that is closer to the bottom of the leading mine was tested. This testing methodology was adopted from the beginning of the exploration of the field and was applied until the end of the exploration of the field.

Well testing was carried out on core and sludge. The sample was taken half of the core, split along the axis; the second half of the core has been preserved. The lengths of the intervals tested are generally equal to 1.0-1.5 m. Due to the low percentage of core output, the length of the tested interval usually exceeded 2.0-2.5 m. The length of core samples was determined by the thickness of individual lithologically heterogeneous in lithology and degree of change rocks cut by the well, as well as the thickness of various mineralized zones. To determine the content of associated components (Ag, Au, Cu, Cd, Bi, etc.), combined samples were compiled from duplicates of the main samples.

In total, over the entire period of its exploration (1950-1960), 10,627 samples were taken, of which 2,994 samples (about 30% of total) were included in the calculation of reserves (inventory calculation), and internal and external controls were made for most of these samples.

The samples were processed mechanically in a crusher, according to the scheme, using formula as referenced in (1). The coefficient k is adopted by analogy with other polymetallic deposits of the region for which it was specially calculated. The grinding of samples was carried out up to 1 mm. Mixing of the sample material was carried out using the ring and cone method, and reduction was carried out by quarting.

Samples of the Galenit deposit were analyzed, up to and including 1954, in the central chemical laboratory of the Uzbek Geological Department. After the transfer of the deposit to the Tajik Geological Administration, analyzes were carried out until May 1956 in the central laboratory of the Office in Dushanbe. From May 1956 until the end of exploration, analyzes were carried out in the chemical laboratory of the Kanimansur expedition. Samples were analyzed for lead, zinc and partially for copper. The determination of lead, zinc and copper was carried out by the polarographic method. Gold and silver analyze were performed by the Central Laboratory of the Tajik Geological Administration and the laboratory of the Sredaztsvetmetrazrazvedka.

In the second half of 1956, the expedition organized a spectral laboratory. The laboratory performs a semi-quantitative analysis of 56 elements. With the organization of the spectral laboratory, only those samples began to undergo chemical analysis, according to which the content of the main components, according to spectral analyzes, was at least tenths of a percent.

The analyzes of the Central Laboratory of the Uzbek Geological Administration were monitored by the Central Laboratory of the Kazakh Geological Administration and, in part, by the laboratory of the Sredaztsvetmetrazvedka trust; analyzes of the laboratory of the Tajik Geological Administration - the laboratory of the Kazakh Geological Administration, analyzes of the laboratory of the Kanimansur GRE were controlled by the laboratories of the Tajik Geological Administration.

The main analyzes, according to external control data for lead, are somewhat underestimated, and according to internal control data, somewhat overestimated. The absolute average value of the systematic error for lead does not exceed thousandths of a percent, which indicates the sufficient reliability of the analyzes.

In 1952, geophysical work was conducted on the area and in the vicinity of the Galenit field. The work was carried out by the Uzbek Geophysical Expedition. The expedition carried out experimental and methodological work, the purpose of which was to develop a comprehensive methodology for prospecting for deposits of polymetals and rare elements (tin and tungsten) in various geological conditions using electrometry, magnetometry and spectrometallometry.

Along with the search, the expedition carried out parametric studies of the electrical magnetic and gravitational properties of the rocks.

Level of knowledge / confidence in assessments

Geological or other aspects

Geological map of Galenit deposit and its cross-section are presented in Fig.2 and Fig.3, respectively.

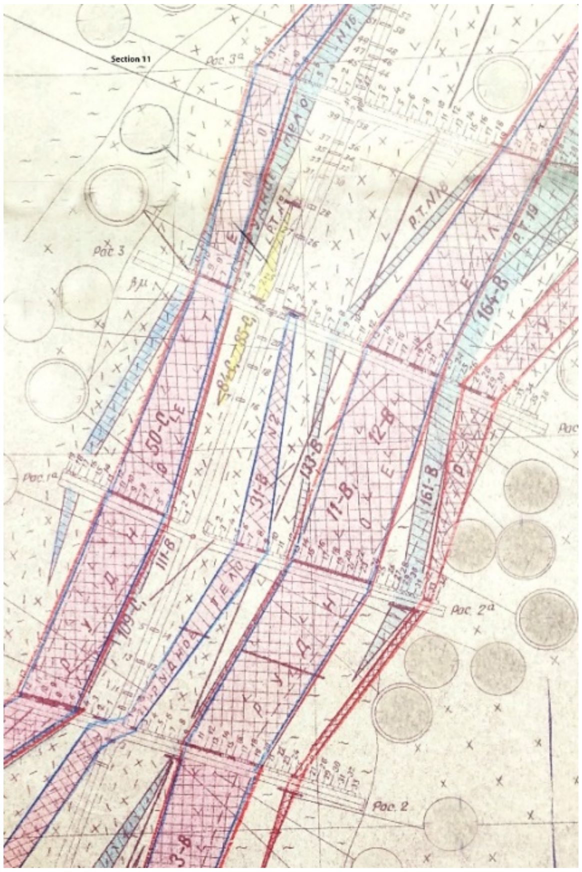

Fig.2 – Geological map of Galenit deposit

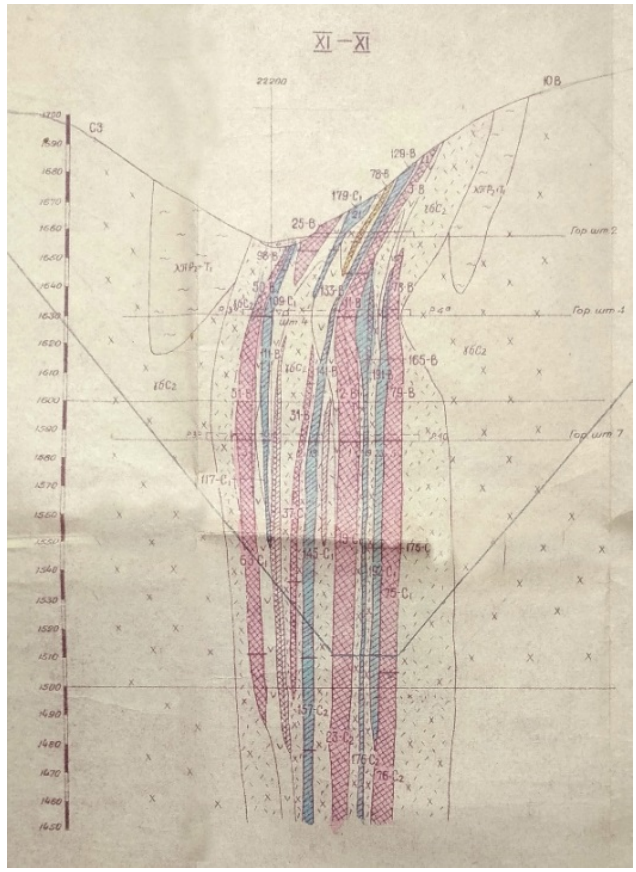

Fig.3 – Cross-section of Galenit deposit

The Galenit polymetallic deposit is confined to the fault of the same name, the seam of which is made of a powerful quartz residential complex. Mineralization is confined to a quartz vein, less often to altered silicified granodiorites, felsites and granites. The length of the ore-bearing zone reaches 1.2 km, with a thickness of 5 to 60 m.

According to the sampling data, 4 main ore bodies and 11 balance ore lenses are identified within the ore-bearing zone. According to the fall, the length of the waste ore bodies varies over a wide range. The strengths of ore bodies along strike and dip are unstable with a coefficient of variation 80-155. The contents of lead, zinc and associated components along the ore bodies are uneven; the degree of variability of the contents is characterized by a coefficient 80-135.

According to the instructions for applying the classification of reserves to deposits of lead and zinc ores (1951), the Galenit deposit should be assigned to the second subgroup of the second group according to the complexity of the structure. In 1954 According to the complexity of the structure of ore bodies, the Galenitskoye deposit was assigned to group III, which corresponds to the second subgroup of the second group of the existing classification. The correctness of classifying the field as group III was confirmed in the reviews of the report and the GKZ RT protocol.

For the field of the second subgroup, category B includes reserves explored by mine workings on a 50x20 m or 60x3 0m grid. Category B reserves qualify for the Galenit field as concluded between the surface and the first adit horizon, as well as within the horizons of mine workings, passed along a 25x50 m and 50x50 m grid. Category C1, in accordance with the requirements of the instruction, includes reserves explored by mine workings for sulfur of 50x100 m. In addition, category C1 is assigned adjacent to the mine workings and the contouring of interpolation at half the distance between the horizons and the workings and extrapolation of 75 m below the horizon. Reserves of category C2 are contoured by an external circuit, by extrapolation (100 m), and also based on geological forecasts. Suspension 75-100 m below the explored horizon was taken on the basis that wedging of ore bodies with depth at the deposit is not observed.

Field development and its effectiveness

Field development is possible both underground and open pit. However, open-cast mining has several undeniable advantages, which allows it to be recommended as the main method of development. The mining conditions for underground mining of the deposit, due primarily to the extreme instability of the rocks of the fault zone, are very complex; as a result, the use of high-performance and economic development systems will be associated with great difficulties.

For mining a quarry, adverse mining conditions will not have a significant impact. The presence of exposed quartz veins with mineralization up to 30 m high allows you to work out the upper part of these veins with minimal overhead costs. The volume of overburden operations is also significantly reduced due to the absence of deposits overlapping ore bodies.

The development of the field to a depth of 160-185 m in the central part and 110-120 m on the flanks should be carried out only in an open way, as a result of which about 80-90% of all reserves of categories B+C1 will be worked out. Great economic effect can be obtained as a result of using tunnels adits, which are passed through 15 m. Using spurts will drastically reduce the cost of expensive drilling operations and will allow powerful massive explosions along the entire length of the quarry.

The schemes for calculating the overburden coefficient during ore mining by the mining method are shown in Fig. 4 and 5.

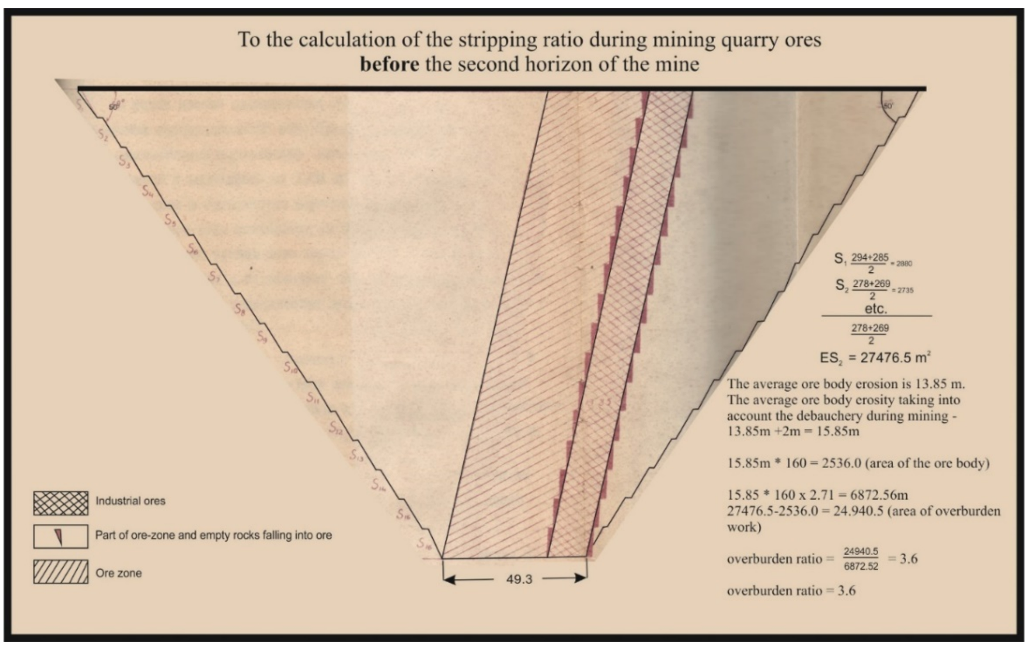

Fig.4 – Scheme for calculating overburden coefficient during ore mining before second horizon

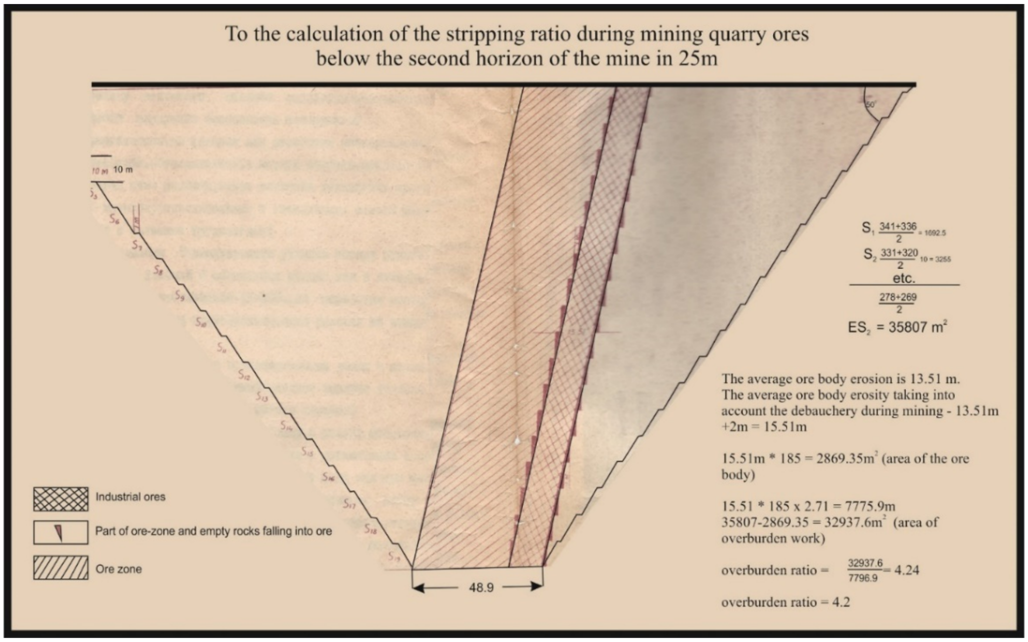

Fig. 5 – Scheme for calculating overburden coefficient during ore mining below second horizon

On the south-western flank under the dump of empty rocks, sai Maly Kazhnopsay can be used, in the central – Tudaksai, and in the north-eastern part – Kansai. Underground mining with any system will be unprofitable but considering that open-pit mining will achieve greater profit, it makes sense to conduct underground mining another 150-200 m below the final pit depth.

Calculation of quantities and volumes

Exploration work for Galenit deposit began in 1950. On the recommendation of GKZ RT, exploration of the field was continued to a depth using two horizons of mine No. 1. According to the protocol No. 474 of the meeting of the commission, the following conditions were approved for the Galenit field:

1. The minimum industrial grade of conditional lead in the ore according to the calculation unit, taking into account the extraction of zinc, silver and cadmium, is taken to be 2.50%; zinc in oxidized ores is not taken into account.
2. The boron content of conditional lead in the sample when contouring the balance ore is taken to be 1.30%.
3. The conversion of zinc into conditional lead is carried out at a rate of 0.6.
4. The minimum capacity of the ore body included in the calculation of reserves is 1.0 m. With a lower power of the body and a high content of valuable components in the ore, be guided by the corresponding metro percent.
5. In areas of ore bodies of high power, interlayers of non-conditioned ores and waste rocks with a thickness of up to 2.0 m are included in the calculation of balance reserves.
6. The onboard content of conditional lead in the sample for contouring off-balance reserves is 0.7%.
7. In the balance ore circuit, reserves of associated components are calculated: silver and cadmium.

In these geological conditions and with the adopted exploration system, the most acceptable methods for calculating reserves are the methods of geological and operational blocks and the method of sections (horizontal sections). A combined method of counting simultaneously by 2 of the above methods is also possible.

The average contents of lead, zinc and associated components from exploratory sections were calculated using the arithmetic mean method, since, mainly, mining samples were taken in meter sections, with the exception of some samples taken from surface mine workings. For balance and off-balance ore lenses, in the absence of analyzes, the cadmium, bismuth and silver contents were taken according to the graph of the correlation between the associated and main components (Fig. 6, 7, 8). To check the accuracy of reserve estimation by various methods, a comparative calculation was made of the reserves of lead and zinc for ore body No. 5 using the method of geological blocks, the results of which are shown in the table below (reserves calculated using the horizontal section method are taken as 100%). Reserves calculated by category using the horizontal section method – lead 15.2 thousand tons – 100%; zinc 76.6 thousand tons – 100%. Reserves calculated by the method of geological blocks of lead 15.2 thousand tons – 100%, zinc – 80.53 thousand tons – 105.1%.

Ore bodies were contoured according to the requirements of approved standards. Category B included reserves concluded between exploratory horizons, if the height between them did not exceed 50-60; also, reserves located between the surface and the horizon of mine workings, if the latter was separated by no more than 60 m from the surface. Blocks of reserves of category B, the conclusion inside the ore bodies, relied on mining. Analysis of geological data allows us to conclude that mineralization extends to great depths without visible pinching and deterioration of ore quality. At the same time, the deposit has been explored on average only 150 m, with a total length of the ore-bearing zone exceeding 1100 m. Considering the foregoing, extrapolation of C1 reserves below the internal contour was performed at 75 m, i.e. half the average intelligence depth. Category C2 reserves were suspended from the lower block of C1 reserves by unlimited extrapolation per 100m. The contents and capacities for blocks of category C2 were taken overlying horizon. reserves on balance lenses uncovered by one or more workings belonged to category C1. Sampling and determination of volumetric weights of ores were carried out systematically during the entire period of exploration of the deposit for all exploratory horizons.

Given that sulfide ore samples were taken below groundwater, the water saturation coefficient should not differ significantly from the humidity coefficient. For oxidized ores, the water saturation coefficient should be significantly higher than the humidity coefficient, since the zone of oxidized ores is above the level of groundwater and the ores are practically dry. The water saturation coefficient is 2.31, and the porosity coefficient is 6.28. A relatively high coefficient of water saturation of bundles with high porosity of ores due to leaching of ore minerals.

Using the geological map, the contours of the ore bodies between the exploration sections were refined, the average strike of the ore bodies was determined, the elevations of the centers of the ore bodies were taken to make projections, etc.

On the testing plans, ore bodies with industrial off-balance contents were outlined in accordance with the conditions, blocks were detuned in a horizontal plane, etc. On the plans, the main data of the test results are written out in special tables: numbers, samples, their lengths, lead, zinc, copper, bismuth and cadmium contents in weight percent, and silver – in grams per ton of ore.

Geological sections were compiled after 100 m, and in some cases, to clarify the geological structure and morphology of ore bodies, sections were compiled after 50 m or more.

Total reserves calculated for Galenit field and the surrounding area are presented in Tab.3 above.

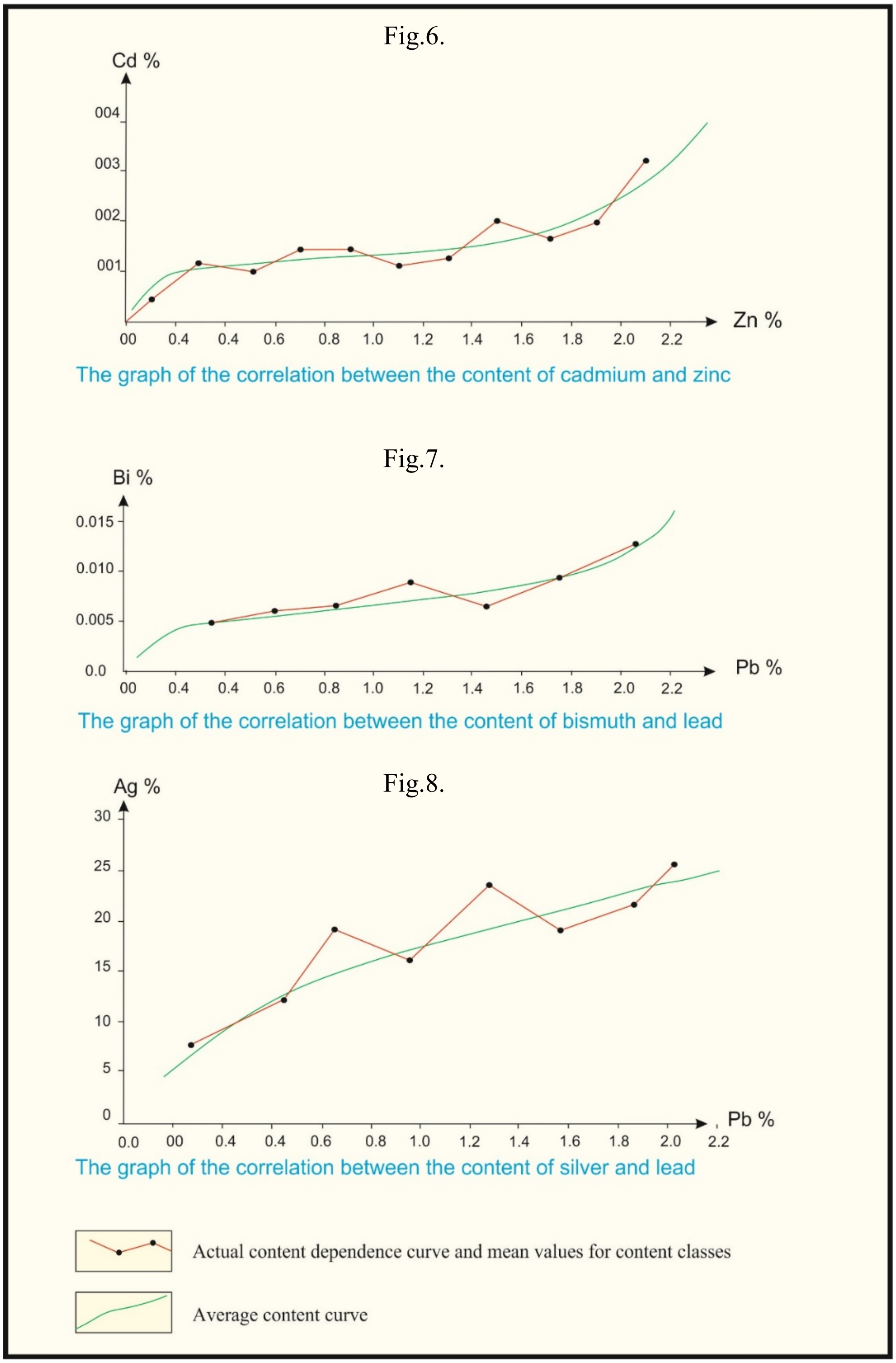

Fig. 6, 7, 8 – Correlation between the associated and main components for the purpose of cadmium, bismuth and silver contents estimation in balance and off-balance ore lenses

Classification of the selected projects using UNFC

Overview of socio-economic information, including social and environmental (E axis)

The lead-zinc deposit Galenit is explored in detail and prepared for operation. The reliability of the estimated reserves is high. The feasibility study for the development of the deposit gives grounds for the fact that with the option of annual extraction and processing of ore in the amount of 200 thousand tons, the enterprise will operate for up to 28 years. A significant part of the budget is formed by the enterprise in the form of taxes.

Therefore, the socio-economic feasibility of ore mining, concentrate production and marketing can be classified in accordance with UNFC-2009 in category E1.

Review of project feasibility information (F-axis)

The high quality of ores of the Galenit deposit, the compactness of the ore bodies, the high degree of their exploration, continuous field exploration at the deposit, and the stable sale of products (concentrates) ensure a stable economic position of the enterprise with satisfactory internal rate of return (IRR) performance of 11.6% and average annual profit for the entire period of development. Some of the reserves of the deep horizons of the field (about 20%) that have not yet been discovered by underground mining are characterized only by preliminary technical and economic assessments. Therefore, the feasibility study of ore mining, production of concentrates and their marketing can be classified according to UNFC-2009 in category F1.2.

Review of geological knowledge / confidence in estimates (G-axis)

The latest assessment of the field's reserves, made by 3D modeling using Micromine, while ensuring proper quality control of testing and analytical work, confirmed by studies comparing exploration and production data, provide a high degree of confidence in the estimates. At the same time, on the deep horizons of the deposit, where production exploration has not yet been carried out, some of the reserves have been studied with a lower degree of detail than on those horizons where ore is mined. This part of the reserves is characterized by less confidence in valuations.Therefore, the degree of geological exploration and confidence in reserves estimates of the Galenit field can be classified according to UNFC-2009 into F1.2 categories.

Classification of the project using UNFC scheme

Based on the above review of the Galenit project on the axes of the UNFC-2009 classification, lead-zinc ore reserves can be classified as E1, F1,2, G1,2.

CASE STUDY II: APPLICATION OF UNFC TO OIL DEPOSIT NAFT

Introduction

The Naft oil field is located in the southern part of the Vakhsh valley. Exploratory wells in the field's area covered deposits of Neogene, Paleogene, Danish and Cenonian age, while exploratory wells No. 31 and No. 32 also uncovered the upper part of the Turonian.

Oil reserves of the second horizon are classified by category B amounting to 8.4 million tons. Recoverable reserves amount to 3.36 million tons. Oil reserves of the first horizon are classified by category C1, belong to off-balance and amount to 173 thousand tons. By recoverable oil reserves according to the classification of GKZ RT of the Republic of Tajikistan, the field belongs to the category of small fields.

Description and details of the national classification and management system

The classification of GKZ RT establishes uniform requirements for the classification of reserves and resources of oil, natural hydrocarbon gas (free gas, gas caps and gas dissolved in oil) and condensate, their accounting for the state in the subsoil according to the degree of their knowledge and development. The basic concepts of categories of reserves and categories of resources are used in the classification of GKZ RT.

Oil, gas and condensate resources are subdivided into promising (category C3) depending on their degree of knowledge. Category C3 – estimated resources prepared for exploratory drilling within the oil and gas region. Estimated resources are used in the planning of exploratory work.

Reserves of oil, gas, condensate and related components are divided into proved categories A, B, C1 and previously estimated (unopened) categories C2. Category A – reserves are calculated based on the field (or part thereof) drilled in accordance with the approved field development project and serve as the basis for optimizing the system and the process of developing oil, gas and condensate reserves. Category B – reserves are calculated on the basis of the field (or part thereof), drilled in accordance with the approved technological scheme of field development, and serve as the basis for the development of the project. Category C1 – reserves of the field (its parts), the oil and gas potential of which is determined based on commercial inflows of oil, gas and condensate obtained in wells, and positive results of geological and geophysical studies in unverified wells. Category C2 – reserves of the field (its parts), the presence of which is justified by the data of geological and geophysical studies.

Comparison of the classification of GKZ RT with UNFC

The classification of field reserves, prospective and forecast oil and natural gas resources reflects the results of a phased geological study of the subsoil. Stages of the study of the subsoil are carried out by implementing the relevant projects. Each project has goals, deadlines, quality requirements and specific risk levels. There are 4 main stages of the study of mineral resources, while each stage of the study of mineral resources has a specific assessment of resources and reserves by categories: regional, exploratory, exploratory and operational.

Reserves of category C1 are calculated based on the results of exploration and development work and should be studied to the extent that they provide initial data for the development of the technological scheme of the field. They can be distributed based on drilling and well testing, provided that commercial oil and gas flows are received. Reserves of category C2 are calculated in unexplored parts of the field adjacent to areas with higher categories of reserves. They are used to determine field prospects, to plan exploration work, or to design field development.

Similar principles for phased exploration and project management are set out in the UNFC. With a certain degree of conditioning, the categories of geological exploration within the UNFC can be compared with the classification of the GKZ RT, for example:

- category G4 is comparable to resource category C3,
- category G3 – from the valuation category of reserves C2,
- category G2 – with reserves categories C1 and C2,
- category G1 – with reserves categories A, B.

It is also tentatively possible to compare the criteria for the status and feasibility of a field development project under UNFC with phased subsoil use projects in the Republic of Tajikistan:

- category F4 under UNFC is comparable to regional work,
- category F3 under UNFC is comparable to the exploration stage,
- category F2 under UNFC is comparable to the exploration stage,
- category F1 under UNFC is comparable to field development.

The study of a specific area in G1 category, the economic feasibility of production and sale in the G1 category within the framework of the UNFC, is achieved through the phased implementation of projects from F4 to F1.

Background information on Naft deposit project

Previous work

As a result of exploration drilling on the anticlinal fold, two oil deposits were discovered in the Bukhara rock-layer (Lower Paleogene). The largest deposit is confined to fractured dolomitic limestones of the second horizon. The second, a small deposit, is contoured in the carbonates of the first horizon. Well-developed fracturing in both horizons leads to a fairly high productivity of wells.

The Naft deposit was introduced into prospecting work in 1959. A total of 9 wells were drilled. Of these, 2 prospecting and 7 exploratory with a total footage of 13,932 m. The distance between the wells is 400-700 m, between the profiles 700-750 m. As a result of drilling, the presence of oil deposits in the first and second horizons of the Bukhara layer of the Paleogene, the configuration of the deposits and the conditions of occurrence of oil were established.

During the test, all wells were put into trial operation in order to clarify operating mode of the first and second horizons of the Bukhara rock-layers. Average production rates for wells range 40-150 m^3/day. The total amount of oil produced during operation amounted to 15,800 tons.

Comparison of geological and geophysical data on exploratory wells of the deposit area shows that most of the section of the Bukhara rock-layers are represented by highly porous, permeable rocks that can serve as good oil and gas reservoirs, and the total reservoir thickness in the section of productive deposits of the Bukhara rock-layer reaches 100 meters, which is a favorable factor to accumulate in them industrial reserves of oil and gas. The oil reserves of the second productive horizon are classified according to category B, belong to the balance and in accordance with the accepted calculation parameters amount to 8.4 million tons. Recoverable reserves with a recovery factor of 0.4 are 3.36 million tons. Oil reserves of the first horizon are classified by category C1 and belong to off-balance, and in accordance with the accepted calculation parameters make up 173 thousand tons.

Current status of the project and prospects

The most effective method for identifying enclosed structures, such as Naft deposit, is structural drilling, the results of which provide the most justified materials for setting up exploratory drilling. Of the 9 exploratory wells drilled at Naft deposit, only 1 well was beyond the oil content circuit.

By drilling wells on Naft deposit, industrial oil content was established, deposits were contoured, and oil reserves were calculated by categories C1 for the first horizon and B for the second horizon of the Bukhara Paleogene layers.

According to well testing and trial operation, the most rational system and field development regime were selected. The efficiency of production intensification by hydrochloric acid treatment of the bottom-hole zone has been verified.

Exploration of the Paleogene and Upper Cretaceous sediments in the area is completed, and the further direction of prospecting and exploration should be focused on deposits of the Lower Cretaceous and the Jurassic system.

Socio-economic and socio-environmental aspects of the project

The planned implementation of the project is desirable from a socio-economic point of view and is possible without harmful environmental consequences.

Economic aspects

The total cost of exploration for the field amounted to approximately 3.1 million US dollars. According to estimates, recoverable oil reserves amount to 3.36 million tons. The performance indicator of exploration is expressed in 236.9 tons of oil per meter of deep drilling. At a total cost of all types of work carried out on the area of the Naft field for the discovery and exploration, 1 ton of oil is worth 0.94 US dollars. With a total cost of exploration of 2.16 million US dollars, the cost of exploring 1 ton of oil is 0.65 US dollars.

Social aspects

In terms of subsoil users, the oil company is engaged in the search, exploration, development of oil and gas fields and oil production, with further sale of commercial oil in the domestic and foreign commodity markets. At the same time, Naft deposit with estimated oil reserves is not an object for covering expenses on social problems of the region. With the commissioning of an oil refinery, Naft deposit can be considered an object of providing the enterprise with raw materials. The commissioning of the enterprise will provide an opportunity to create new jobs in the region.

Environmental aspects

As part of the development of the fields, a preliminary assessment of the impact on which may cause unwanted changes in certain components of the environment, is developed. The area of planned activity is limited to a sensitive area of anthropogenic impact, in which minor changes are expected as a result of economic activity. In order to avoid negative impact on environmental components, environmental protection measures must be carefully observed. In this regard, technologies and technical solutions that would have the least impact on the environment were included in the project. The main components of the affected environment are the air basin, water area, subsoil, flora and fauna of the territory and the social environment.

Based on the analysis of the current situation, the design decisions made, and the consequences predicted by them, maps for calculating the dispersion of pollutants in the surface layer of the atmosphere were additionally modeled. Pollutant emissions do not exceed the maximum permissible standards.

Status of field projects and feasibility

Technological aspects of feasibility

The first exploratory wells, based on structural drilling materials, focused on the search for oil and gas deposits in Paleogene and Cretaceous deposits. However, due to the low hypsometric position of the field in the structure of the Kyzyltumshuks ridge, the date and senon horizons turned out to be flooded, and the most promising deposits of the Cenomanian and Alb, which are associated with large oil and gas deposits in neighboring states, were unattainable due to abnormally high reservoir pressures aquifers in turon.

Since the Naft deposit is floating (it is supported by the pressure of the bottom and marginal waters), it is advisable to arrange the wells on a uniform grid in such a way as to avoid premature flooding with contour and bottom water. In addition, this arrangement of wells is dictated by the high viscosity of oil in the reservoir. Considering the detailed study of the field and using the data obtained, the following conclusions can be drawn:

1. To develop deposits, apply a uniform grid over a square system with distances between wells of about 250 m.
2. It is necessary to open the formation at its full capacity, perforation should be performed at 1/4 of the formation's capacity, counting from the roof of the horizon.
3. It is mandatory to carry out hydrochloric acid treatment of the bottom of the well, which often leads to an increase in well productivity by a factor of tens. This will significantly reduce the development time of the deposit.
4. Buffer pressure below 1.5 atm at the beginning of operation is impractical to reduce.
5. In order to maintain reservoir pressure and maximize oil recovery during field operation, consideration should be given to injecting gas or air into the reservoir.

Level of knowledge / confidence in estimates

Geological and technical aspects

Based on the assumption of the Brach anticline structure and nature of the deposits (it was supposed to open the reservoir deposits), the following methodology was chosen. Wells were laid along two profiles across the strike of the structure: 2 wells were drilled in the north-western and south-eastern piles of the structure. A total of 9 wells were drilled, among which 2 are prospecting and 7 are exploratory, with a total footage of 13,932 m.

Field-geophysical studies in wells – electrometry – was carried out using the gradient probe method (M2A 0.25B) and the potential probe (B2A 0.25M). Lateral logging was carried out by 5 gradient probes.

In the process of drilling wells, continuous core sampling was carried out in the intervals of occurrence of productive horizons of the Bukhara layers. For some wells, core samples were taken from several intervals of the Danish, Cenonian, and Upper Turonian stages. The position of the water-oil contacts was determined by well test data; for this purpose, geophysical- field research materials were obtained, which were obtained from almost all wells. The oil reservoir of the second productive horizon of the Bukhara layers at the Naft Deposit was discovered by 8 exploratory wells, and 1 well remained behind the oil profile.

According to exploratory drilling data, numerous geological and production-geophysical materials have been obtained with enough coverage of the geological structure of the area, its tectonics, stratigraphy, the position of productive horizons in the section and the change in their properties in terms of oil content. Based on the trial operation of the wells and the study of hydrogeological conditions, which made it possible to determine the reservoir regime, a rational field development system was selected. Based on the physical properties of the oil and the regime of the reservoir, the oil recovery coefficient is conventionally assumed to be 0.4.

Guided by the "Instructions for the application of the classification of reserves to oil and gas fields" and considering the above, oil reserves of the second horizon of Naft Deposit are classified as B.

Classification of Naft project using UNFC

Overview of socio-economic information including social and environmental (E axis)

The results of exploration could not determine the economic viability of oil production due to lack of information. Thus, the economic feasibility of oil production and sales during the exploration phase can be classified in sub-category E3.2 of UNFC-2009. The economic feasibility of oil production and sales during commercial development as part of UNFC-2009 can be classified into categories and subcategories E1.1 and E2.

View project feasibility information (F axis)

The work performed on Naft deposit during the exploratory phase from the point of view of project feasibility (axis F) is categorized as F3 according to UNFC-2009. To confirm the presence of a deposit (or deposits) on the identified prospective structures, it was necessary to conduct additional exploration work. Most of the area has been drilled by exploratory wells, but commercial production has not yet begun. This said, the feasibility of the project in accordance with UNFC-2009 should be classified as F1.1 and F1.2.

Overview of geological knowledge / reliability of estimates (G axis)

The resource assessment of the field was based on data from exploratory drilling and field geophysical work. Such data, which are largely similar to data for the region, are characterized by a significant range of uncertainty. Therefore, according to UNFC-2009, the exploration and reliability of the estimates (G axis) correspond to category G4. Exploration work and the reliability of estimates at Naft deposit can be classified as G1+2.

Project classification using the UNFC scheme

Based on the above project overview, along the three axes of UNFC-2009 oil reserves at the Naft deposit can be classified as follows: E1.1, E2, F1.1, F1.2, G1 + 2.

Oil reserves of industrial categories B+C1 correspond to E1.1, F1.1, G1 according to UNFC-2009. Oil reserves of C2 grading categories correspond to E2, F1.2, and G2.

ALIGNMENT TO SUSTAINABLE DEVELOPMENT GOALS IMPLEMENTATION

The Republic of Tajikistan is taking initiatives related to use of hydropower resources, which is a priority in providing the population of the Republic with electricity. Tajikistan has abundant hydropower resources. Due to the availability of rich hydropower resources, measures for the large-scale development of sources of thermal energy in Tajikistan have not yet been resolved. Outcomes from an integrated approach to coal reserves in Tajikistan and the allocation of energy resources, Tajikistan, while developing in the future, while maintaining the priority development of hydropower, will have to make serious efforts to develop thermal energy as an important complement to hydropower, eliminate the bottleneck in Tajikistan's energy sector, and support normal functioning economy of the country and the life of the population.

In the Republic of Tajikistan, industry is the leading branch of material production. A significant part of the gross domestic product of almost any country in the world is being created in this industry. State industrial policy should be multidirectional, and various instruments and mechanisms should be used to solve it, starting with fiscal measures and ending with attracting foreign investment. The Government of the Republic of Tajikistan has been given the task of taking measures to transfer the Republic from agrarian-industrial to industrial-agrarian. The following objectives have been adopted in the field of mineral resources:

1. Increase in the volume of production and sale of industrial products competitive in domestic and foreign markets;
2. The organization of an effective system of reproduction of personnel capable of creating and mastering industrial technologies, producing innovative products;
3. The creation of an institutional framework for the sustainable and preventive development of industries, the creation of innovative high-performance clusters, and
4. The development of a national system of selective import substitution based on the processing of local resources.

Of great importance in the Republic of Tajikistan is the construction of roads and railways. One of the strategic tasks of the state is to bring the country out of the communication deadlock, opening roads in all directions. With this task, the country has practically recovered. Now there are roads in all directions. The country's railway network is also developing. The government is doing everything to raise the living standards of the population. Every year the budget financing of the main types of production is increasing.

The Government of the Republic of Tajikistan has set a task for companies to produce competitive products within the country. Subsoil users should switch to the production of final products, i.e. measures are being taken to reduce the export of ore concentrates from deposits abroad. During the construction of metallurgical plants, new jobs will appear and, accordingly, replenishment of the state penalty will occur due to tax injections.

The President of Tajikistan noted at the conference “Water for Sustainable Development 2018-2028”: “Long-term observations indicate the increasing impact of climate change on the nature and socio-economic situation in Tajikistan and Central Asia. According to these observations, over the past sixty years, the average annual air temperature in Tajikistan has increased by one degree Celsius, the frequency and intensity of natural hydrometeorological phenomena have increased.”

In terms of climate, Tajikistan is one of the most vulnerable countries in the entire region of Europe and Central Asia. 93% of the territory of Tajikistan is mountains, and only 7% of the land is considered flat. The population is 9 million people, and for every inhabitant there is only 0.06 hectares of irrigated land. Tajikistan is highly vulnerable to shocks caused by climate change, such as droughts, floods, landslides, etc. It is estimated that by 2050, up to one third of glaciers in Central Asia will completely disappear, which will sudden increase the risk of flash floods from breaking glacial lakes.

The Government of the Republic of Tajikistan annually allocates budgetary and extra-budgetary funds for the prevention and liquidation of natural disasters. A significant part of these funds is directed to the resettlement of the affected population, the provision of material assistance to them, as well as to shore protection.

The government is intensifying cooperation with regional and international organizations in the field of natural disaster reduction. There are multilateral and bilateral international agreements on disaster cooperation. Currently, a working group of representatives of the Ministry of Emergencies of Kazakhstan, Kyrgyzstan and the Committee in Tajikistan on the creation of a Central Asian center for disaster risk reduction is functioning in Almaty. The establishment of this center will facilitate coordination of efforts in this direction. In Central Asia, where water resources are often generated in some countries, and are used mostly in others, there is a need to develop a unified regional strategy for adaptation to climate change-related conditions.

The National Development Strategy of the Republic of Tajikistan for the period until 2030 has been prepared taking into account the changes that have occurred in recent years in the country and the world, the Central Asian region and the Eurasian space, and in particular, the impact of the global financial and economic crisis of 2007-2009 and its consequences on the national the economy. The document specifies the direction of development of the country, defined in the Concept of the transition of the Republic of Tajikistan to sustainable development. The supreme goal of the long-term development of Tajikistan is to improve the living standards of the country's population by ensuring sustainable economic development.

CONCLUSIONS ON UNFC CLASSIFICATIONS OF ENERGY AND MINERAL RESOURCE PROJECTS IN TAJIKISTAN

A systematic approach to sustainable resource management can provide a closer integration of policies, especially programs of sustainable development of a country or company, in the implementation at the project level.

The United Nations Resource Management System (UNRMS) is being proposed as a tool that can link policy objectives with project implementation. Such a set of tools is currently unavailable, and this drawback can be largely explained by the constant drawback in translating policy objectives into practical results observed across the globe. UNRMS draws on its experience with UNFC, which classifies resources into different classes according to three main criteria: socio-economic viability (E), technical feasibility (F) and level of knowledge (G). Thus, UNFC provides a common terminology and classifies resources into projects based on a combination of criteria.

A resource approach to determining the priorities for the development of the export potential of the industry of the Republic of Tajikistan in modern conditions, when there is an active process of integration of the country into the world economy, the role of the natural factor in the development of the Tajik economy is growing. It is this factor that should become the driving force of structural transformations, the formation of new specialized industries and ensure economic growth. In this regard, the assessment of the country's natural resources is one of the important components of solving the problem of increasing the export potential of the Republic.

The country's natural resources can be defined as the initial base of production, based on which the national economy is developing. It consists of bioclimatic, fuel and energy and mineral resources:

1. Bioclimatic resources. Tajikistan has unique climate conditions. Climate as a natural resource is an important factor in the development of the entire economy and agriculture.
2. Fuel and energy resources. Tajikistan has unique hydropower resources. The Republic accounts for about 4% of the economically efficient hydropower potential of the globe. The total capacity of all rivers of the Republic is estimated at 32.3 million kW in power or 527 billion kW/h in energy production, of which more than 230 billion kW/h are technically possible and economically feasible today. Based on the foregoing, we can say with confidence that hydropower is the main strategic direction for the development of water resources.
    a. Oil and gas. The main gas and oil regions of Tajikistan are in its northern and southern parts. In the northern part of Tajikistan, prospects for oil and gas have 25 areas. In the southern part of the Republic, about 125 areas have prospects for oil and gas. According to experts, the total geological reserves of oil in Tajikistan are estimated 467 million tons, free gas – 1036 billion m^3.
    b. Coal. In Tajikistan, there are more than 35 coal deposits, for some of them total and industrial reserves are calculated. The balance reserves of coal in the Republic amount to 714.14 million tons, and the forecast – 3703.4 million tons. Coal resources in the Republic's fuel balance account for a large part, therefore their development can not only weaken Tajikistan's dependence on imports of gas and oil products, but also further facilitate the transition to their export.
3. Mineral resources. The territory of Tajikistan is rich in a wide variety of minerals. Of ferrous and alloying metals, deposits of iron, tungsten and molybdenum have been

discovered in the Republic. Of the non-ferrous and rare metals in the subsoil of Tajikistan, deposits of lead, zinc, gold, silver, copper, antimony, mercury, tin, bismuth, strontium and aluminum raw materials are known. Recently, a large amount of exploration and research work has been carried out, which has allowed to identify deposits of fluorspar, boron, glass sand, rock crystal. Mineral deposits have been discovered for the chemical industry – dolomites, rock salt. The Republic has large reserves of raw materials for the building materials industry – limestone, gypsum, mineral paints, marble, granite, lapis lazuli, spinel, turquoise, amethyst, garnet, tourmaline, sapphire, etc.

However, all the resources of the Republic are used in scanty volumes, and some are not used at all. Therefore, the main task is the speedy introduction of these rich natural resources into environmentally and economically justified operation.

Thus, the resource approach helps to determine that the priority sectors in the development of the export potential of the industry of the Republic of Tajikistan in the near and distant future can be the electric power industry, coal industry, mining, non-ferrous metallurgy, chemical, light and food industries.

REFERENCES

1. The Australian-Asian Code for Reporting on Exploration Results, Resources and Reserves of Solid Minerals. JORC Code 2012 Edition Full translation. Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves. The JORC Code, 2012 Edition. Fully translated into Russian - M.: Polymetal International plc, NP NAEN. 2012.137s.
2. Aminov D.G. Resource approach to determining the priorities for the development of the export potential of industry of the Republic of Tajikistan. Peoples' Friendship University of Russia. Moscow, 1915.
3. Instruction on the content, design and procedure for submission to the State Commission of the Republic of Tajikistan on mineral reserves substantiating the constant conditions for mineral raw materials and calculated mineral reserves in the bowels. Approved by order of the head of the Main Department of Geology under the Government of the Republic of Tajikistan dated October 29, 09 No. 13.
4. Classification of reserves of deposits and predicted mineral resources. Approved by the Decree of the Government of the Republic of Tajikistan dated 28.07.09 No. 429.
5. Classification of reserves and prediction resources of solid minerals. Approved Order of the Ministry of Natural Resources of Russia dated 11.12.06 No. 278.
6. United Nations International Classification for Reserves/ mineral resources, Geneva, 1996. (Solid combustible minerals).
7. United Nations Framework Classification for Fossil Energy and Mineral Resources 2009.
8. Decree of the Ministry of Natural Resources of Russia dated 05.06.07 No. 37-r “On the Approval of Methodological Recommendations on the Application of the Classification of Mineral Reserves and Prediction Resources of Solid Minerals”.
9. Guidelines for the harmonization of reporting standards of Russia and CRIRSCO, Agreed by the General Director of the State Budgetary Institution SRC 08.25.10 Moscow, 2010
10. Specification for applying the United Nations Framework Classification for Fossil Energy and Mineral Reserves and Resources 2009 (UNFC-2009) to renewable energy resources. Geneva, 09/30/2016.

ANNEX

Definitions of categories and additional explanations and comparisons with the classification of mineral reserves operating in the Republic of Tajikistan.

Category	Definition	Additional explanations	GKZ RT classification
E1	Confirmed the economic feasibility of production and marketing	Mining and marketing are cost-effective in current market conditions and under realistic scenarios of future market conditions. All necessary approvals / contracts are either already issued, or there are reasonable grounds to believe that all such approvals / contracts will be received within a reasonable time. Short-term adverse market conditions do not threaten economic feasibility if long-term forecasts remain positive.	Balance reserves (economic), the development of which at the time of assessment according to technical and economic calculations is economically effective in a competitive market using equipment, technology for the extraction and processing of mineral raw materials, ensuring compliance with the requirements for the rational use of mineral resources and environmental protection.
E2	It is anticipated that production and marketing will become economically viable in the foreseeable future.	The profitability of production and sales has not yet been confirmed, but on the basis of realistic forecasts of future market conditions, there are reasonable prospects for profitable production and marketing in the foreseeable future.	Off-balance reserves. Such reserves, even with a sufficiently high degree of knowledge, cannot be comparable with designated and withdrawn resources, since their development at the moment is obviously economically unprofitable. However, with big reservations, off-balance reserves can be included in the feasibility study for future mining.
E3	It cannot be assumed that production and marketing will become economically feasible in the foreseeable future, or the estimates are made at a too early stage that does not allow determining economic feasibility	Based on realistic forecasts of future market conditions, it is currently believed that there are no acceptable prospects for profitable production and marketing in the foreseeable future; or the economic feasibility of production cannot be determined due to lack of information (for example, at the assessment stage). Also included are quantities that are projected to be recovered but which are not for sale.	Not regulated

Category	Definition	Additional explanations	GKZ RT classification
F1	Feasibility of production during the implementation of a specific development project or during mining operations is confirmed	Production is currently underway at the field (deposit); either a development project is underway, or mining is ongoing; or sufficiently detailed studies have been completed proving the validity of production during the implementation of a specific development project or during mining operations.	Feasibility studies (Technical-Economical Studies) of feasible permanent conditions are developed on the basis of materials from completed exploration work and have as their goal the establishment of the scale and industrial value of the field to determine the feasibility and economic efficiency of its industrial development, and accordingly, to decide on financing an investment project for the development of the field. Moreover, all estimated financial calculations for the accepted version of the field's industrial development are carried out within the framework of the real acceptable values of all modifying factors. The overall validity of the study should be characterized.
F2	The feasibility of mining in the implementation of a specific development project or during mining requires further evaluation	Preliminary studies show the presence of deposits or deposits of such shape, quality and quantity that the feasibility of production using a specific (at least in the broad sense) development project or mining can be evaluated. Additional evidence and/or studies may be required to validate production.	A feasibility study of temporary conditions is a variant study to justify rational methods and systems for field development and an effective technology for processing raw materials. An integral part of the feasibility study is a financial analysis based on realistically acceptable values of technical, structural, operational-production and economic factors sufficient to establish recoverable reserves in the volume of the field, the viability of the mining project and, accordingly, the feasibility of investing in further exploration work depend on the quantity and quality of the deposit. The overall validity of the study should be characterized.
F3	The feasibility of production during the implementation of a specific development project or during mining cannot be evaluated due to a lack of technical data.	The most preliminary studies (for example, at the stage of geological exploration), which can be based on a specific (at least conceptually) development or mining project, indicate the need to collect additional information in order to confirm the presence of a deposit (or deposit) such a form, quality and quantity of raw materials that it will be possible to assess the validity of production.	The estimated deposits, the reserves of which, their quality, technological properties, hydrogeological and mining engineering conditions have been studied to a degree that allows us to justify the feasibility of further exploration and development. According to the degree of knowledge, the estimated deposits must satisfy the following requirements: (1) it is possible to qualify all or most of the reserves in category C2; (2) the material composition and technological properties of the mineral are evaluated with the completeness necessary to select a basic technological scheme of processing that ensures the rational and integrated use of the mineral.

Category	Definition	Additional explanations	GKZ RT classification
F4	No development or mining project	Subsoil quantities of raw materials (in situ) that cannot be mined by any of the currently existing mining development or mining methods	Not regulated
G1	Quantities assigned to a known deposit that can be estimated with a high degree of confidence	To estimate the amounts in the bowels of the energy and mineral resources extracted in the form of solid minerals, they are usually divided into discrete categories, where each discrete estimate reflects the degree of geological exploration and reliability related to a certain part of the field. Ratings are classified into the corresponding categories G1, G2 and / or G3. In the case of evaluating the liquid recoverable resources of fossil fuels and minerals, their mobility usually does not allow attributing the recoverable quantities to individual parts of the field or deposit. Recoverable quantities must be estimated based on the impact of the development scheme on the field as a whole and categorized based on three scenarios or outcomes equivalent to categories G1, G1 + G2 and G1 + G2 + G3.	Proved reserves / exploitation reserves in explored deposits represent an estimated category of the highest degree of reliability, both from a technical and economic point of view. Based on this, the main criteria for highlighting this category are: (1) the degree of geological reliability of proven reserves / "operational reserves" in explored deposits should correspond to the degree of geological reliability of the measured resources / "reserves of category C1 (A, B); (2) the reliability of the assessment of all admissible modifying factors should be sufficient to make a decision on financing and implementing an investment project for the development and development of the field. A mandatory attribute of the reliability assessment is a sensitivity analysis, which shows the influence of possible deviations of the characteristics of the most important modifying factors from the actual ones, taken in the calculation of technical and economic indicators and the integrated development efficiency of the field.
G2	Quantities assigned to a known deposit that can be estimated with an average degree of confidence.		Probable reserves / operational reserves at the evaluated fields have a lower level of reliability than the proven ones, but their assessment has a quality level sufficient to serve as the basis for a decision within the company on exploration and subsequent involvement of the field in commercial operation, taking full account of current factors risk. Based on this, the main criteria for highlighting this category is that the degree of geological reliability of probable reserves / "operational reserves" at the estimated fields should correspond to the degree of geological reliability of the estimated resources / "reserves of category C2" (deposits of all complexity groups) and "reserves of category C1" (deposits of the 4th complexity group).

Category	Definition	Additional explanations	GKZ RT classification
G3	Quantities concentrated on a known deposit that can be estimated with a low degree of confidence.		P1 category forecast resources consider the possibility of discovering new mineral deposits within the basin, mineral province, node or ore field, the estimated presence of which is based on a positive assessment of large-scale geological surveys (with appropriate mapping) and exploration of mineral occurrences. The predicted resources P1 in quantitative terms with reference to local areas serve as the basis for setting up detailed search surveying operations.
G4	Estimated quantities attributed to a potential deposit, based mainly on indirect evidence	The quantities estimated at the exploration stage are characterized by such a significant range of uncertainty and associated risk that subsequently no mining or mining project will be carried out with the aim of extracting these estimated quantities of raw materials. In cases where a single assessment is carried out, it should contain the expected result, however, if possible, the full range of uncertainty regarding the size of the potential field should be documented (for example, in the form of a probability distribution). In addition, it is also recommended to document the possibility (probability) that a potential deposit will become a commercial deposit.	Forecast resources of category P2 consider only the potential for discovering deposits of a mineral based on favorable geological and paleogeographic prerequisites identified in the evaluated region during medium-small-scale geological and geophysical and geological surveying. Quantitatively estimated P2 resources serve as the basis to produce geological mapping at a scale of 1: 50,000 and prospecting.
			Regional geological exploration